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The Morphology of *Renicola philippinensis,* n. sp., a Digenetic Trematode from the Pheasant-tailed Jacana, *Hydrophasianus chirurgus* (Scopoli)

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(Plate I; Text-figures 1-3)

A SPECIMEN of the pheasant-tailed jacana, *Hydrophasianus chirurgus* (Scopoli), was acquired by the New York Zoological Park on October 31, 1956, and died on January 15, 1957. The native habitat of this virtually omnivorous species is southeast Asia and the present specimen was taken in the Philippine Islands, but it had been kept in California for about two months before coming to the Zoological Park. At autopsy, the kidneys contained about fifty sexually mature worms, clearly referable to the trematode genus *Renicola.* Insofar as known, no fish was given the bird during its stay in California, and at the Zoological Park it was fed on North American smelts that had been frozen for a long period, some for several months. It is likely that the bird acquired the infection in the Philippines before its capture and this supposition is strengthened by the facts that no juvenile or immature worms were present in the kidneys, no rhodometopous cercariae or metacercariae have so far been reported on either the Atlantic or the Pacific coast of North America and no other birds in the New York Zoological Park have been found infected with *Renicola,* although large numbers of smelt and other Atlantic fishes are used as food.

Another specimen of *H. chirurgus* received at the same time as this bird subsequently died but showed no trematode infection in the kidneys or elsewhere.

The diseased bird was emaciated and languid when first examined, but exhibited only mild anorexia. It was treated with prednisolone parenterally and aureomycin topically for a pea-sized, bumblefoot lesion on the ventral surface of the right foot. The left tarsus was somewhat swollen and was treated with an intra-articular injection of prednisolone. Two weeks later the lesion was healed but the symptoms remained the same and the bird died the day after the bandage was removed from the right foot, that is, 15 days following initial treatment.

Macroscopically and microscopically, the lesions had the general appearance of polycystic kidneys in which the cystic spaces (enlarged renal tubules) were filled with worms (Pl. I, Figs. 1, 4, 5). As in congenital polycystic kidneys which are seen in mammals and other animals, the cysts were lined with low columnar epithelium (Pl. I, Figs. 4, 5) that had been flattened by pressure from the worms. The tubules and glomerular tufts adjacent to the cysts were compressed and in some areas atrophied (Pl. I, Figs. 4, 5). Extensive regions of the kidneys, however, were normal in appearance and in this respect the pathological condition in the bird differs from typical polycystic kidneys, in which very little cortical tissue is present.

The worms, although hermaphroditic, occurred usually in pairs in the cysts. They were oriented indiscriminately, with about one-half of the body of each overlapping that of the other. All were sexually mature and their uteri were filled with enormous numbers of eggs. Since *Renicola* has not previously been reported from this host or from southeast Asia, a description of the worms is presented. They manifest distinct differences from all previously described species, and are described provisionally as a new species for which the name *Renicola philippinensis* is proposed.

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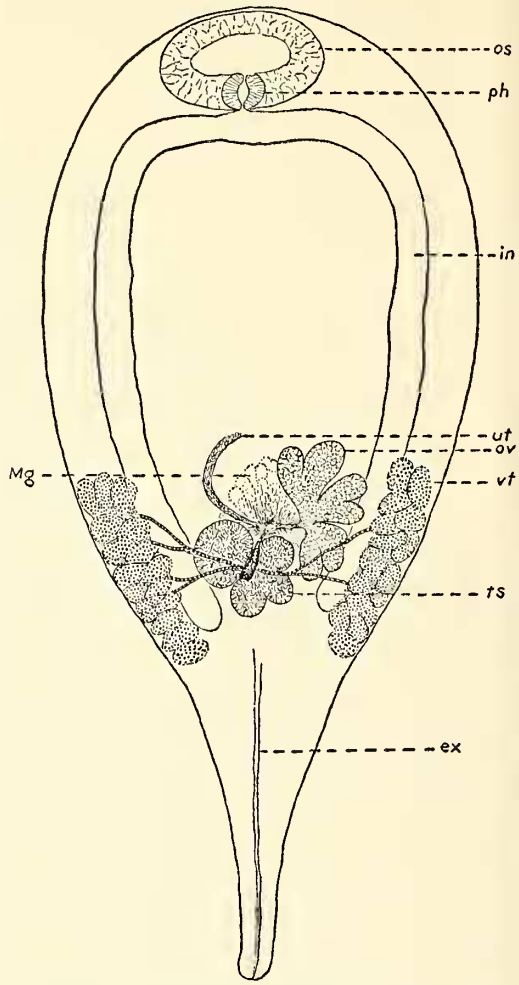
Renicola philippinensis, new species

DESCRIPTION

The body is ovate to pyriform, rounded anteriorly and more or less attenuate posteriorly. The terminal portion may be extended as a narrowing tail-like structure. This region, which is posterior to the digestive ceca and the reproductive organs, may be retracted until it is a mere knob-like protuberance or extended to a length of 0.25 mm. An average and a somewhat extended specimen are presented in Pl. I, Fig. 2. The structural details, coils of the uterus omitted, of the longer worm are shown in Text-fig. 1. The specimens, all gravid, measured 1.7-3.6 mm. in length and 1.0-1.8 mm. in width. The cuticula (Pl. I, Fig. 5; Text-fig. 2) bears relatively slender, distinctly separated, sharp spines. The musculature of the body wall is very weak and movement of the worms was slow rather than vigorous. The acetabulum is shallow, 0.1-0.12 mm. in diameter, and is situated at the testicular level, directly below the vitelline receptacle, about 0.1 mm. posterior to the genital pore. The acetabulum and genital pore are rarely visible in whole mounts, as the enlarged terminal portion of the uterus, filled with dark-colored eggs, lies immediately above these structures and obscures them.

The mouth is subterminal, the oral sucker is usually wider than long and measures 0.4-0.5 mm. in diameter. It is shallow and weak and the tissue is vacuolated, without distinct radial fibers. There is no prepharynx; instead, the pharynx, which measures 0.08-0.11 mm. in diameter, appears to be embedded in the wall of the sucker, with the anterior opening of the pharynx at the base of the concavity of the sucker (Text-fig. 1). The pharynx is provided with radial and circular muscles. From the pharynx, the intestinal ceca follow the lateral contours of the body and terminate at a level between the posterior limits of the testes and vitellaria. The posterior portions of the ceca are compressed between the vitellaria and the gonads. The walls of the ceca are membranous and the epithelium is so flattened that in places it is hardly recognizable. The lumen contains a fibrous precipitate, obviously of a fluid, and no cell fragments were observed. It appears, therefore, that the worms take nourishment in liquid form, by sucking lymph or plasma from the tissues rather than by ingestion of cells.

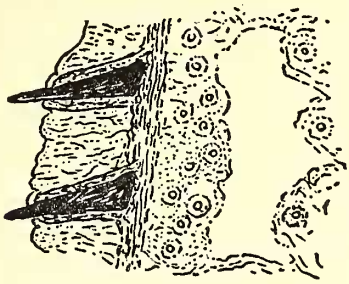
The excretory pore is terminal, the vesicle is Y-shaped, the bifurcation is immediately posttesticular, at the base of the tail-like portion of the body. Both the stem and crura of the vesicle bear lateral evaginations, although those of the stem are indistinct when the posterior end of the body is extended (Text-fig. 1). The flame-cell pattern was not studied.



TEXT-FIG. 1. Morphological details of longer specimen shown in Pl. I, Fig. 2; uterus omitted, dorsal view. Specimen as mounted 2.46 mm. long.

Abbreviations: **OS** = oral sucker; **PH** = pharynx; **IN** = intestine; **UT** = initial portion of uterus; **OV** = ovary; **VT** = vitellaria; **TS** = testis; **EX** = excretory vesicle; **MG** = Mehlis's gland.

The reproductive organs are compressed into a small region near the posterior end of the body (Text-fig. 1). The testes are opposite to oblique, usually contiguous or overlapping, just anterior to the caudal portion of the body. They are spherical to oval to reniform, entire, indented or lobed, 0.2-0.5 mm. in diameter; in the specimen shown in Text-fig. 1 the left testis is entire, almost spherical, whereas the other is distinctly trilobed. Sperm ducts lead mediad and ventrad, uniting to form a small seminal vesicle from

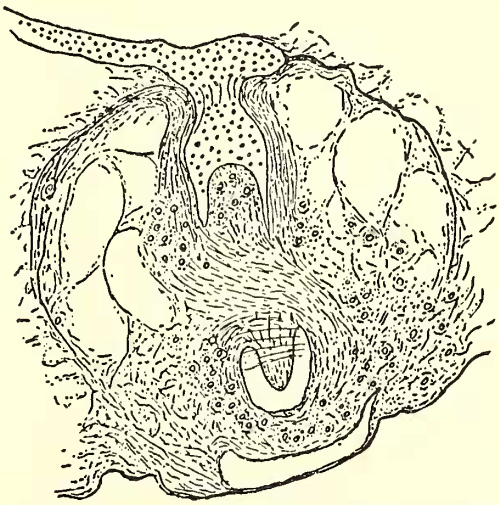


TEXT-FIG. 2. Section of body-wall, showing spines embedded in thick cuticula, and weak musculature; cf. Pl. I, Fig. 5.

which a short duct leads ventrad and opens as a small papilla into a shallow genital atrium (Text-fig. 3). There is no true cirrus-sac, but the initial portion of the ejaculatory duct is enclosed by a few secretory cells and the duct with its surrounding parenchyma is bounded by a membranous covering (Text-fig. 3). The ovary is trilobate, with each lobe more or less divided; it is located on the right side of the body, slightly anterior to but overlapping the testicular zone. It is larger than either testis and measures 0.3-0.5 mm. in greatest dimension. The oviduct arises from the medial face and bears a small evagination, the seminal receptacle, filled with spermatozoa; it then receives the short, common vitelline duct, and expands to form the ootype, surrounded by the cells of Mehlis's gland. The initial bend of the uterus, with colorless eggs, passes forward and mediad as shown in Text-fig. 1. The uterus extends in loops and coils, chiefly on the ovarian side of the body, from the vitelline follicles to the anterior end, courses around the oral sucker and posteriad to the vitellaria of the antovarian side; it then forms a conspicuous mass of coils and the distended terminal end of the uterus discharges through a very short metratermal portion into the genital atrium. The metraterm is only three or four times the length of an egg. The genital pore is ventral to Mehlis's gland. As the eggs traverse the uterine coils, the shells become darker in color. All portions of the uterus, with the exception of the black, terminal, median portion, are pretesticular. The vitelline follicles are oval to clavate, 0.06-0.13 mm. in length; they are lateral and extend forward almost to the level of the anterior lobe of the ovary and backward slightly beyond the ends of the intestinal ceca. Multiple ducts pass mediad, those from either side joining above the testes to form a vitelline receptacle from which the common duct leads anteriad and ventrad to join the oviduct at the beginning of the ootype. The eggs (Pl. I, Fig. 3), produced in enormous numbers, are operculate, embryonated, and measure 0.025-0.027 by 0.012-0.014 mm.

DISCUSSION

Specific Identity.—The number of valid species in the genus *Renicola* is problematical. Dollfus (1946) listed nine species but noted, "Chacune de ces espèces, sauf *lari*, n'a été vue qu'une seule fois, quelques-unes seulement en un ou deux exemplaires, aussi n'ont-elles pas pu être toutes suffisamment bien caractérisées, décrites et figurées." He found only slight differences between *Renicola glandiloba* Witenberg, 1929, *Renicola lari* Timon-David, 1933, and the type species, *Renicola pinguis* (Mehlis in Creplin, 1846). The specimens of Mehlis were from the crested grebe, *Colymbus (Podiceps) cristatus,* and the species was named type of the new genus *Renicola* by Cohn (1904), who found the acetabulum and removed the species from the then accepted genus *Monostomum.* In this paper Cohn made the significant observation that trematodes from closed cavities have reduced and atrophied suckers and that monostomes may be derived from distomes. In addition to the nine previously named species, Dollfus described but did not name specimens from *Mergulus (Plotus) alle* killed at Wimereux, Pas de Calais. Although Dollfus recognized *Stamparia* Neslobinsky, 1926, as a valid genus, Caballero y Caballero (1953) suppressed the name as a synonym of *Renicola* and from the present study it is clear that the grounds on which Dollfus accepted *Stamparia, viz.,* the shape and location of the testes, are much too variable to warrant generic recogni-



TEXT-FIG. 3. Section through the genital atrium showing, above, the union of the sperm-ducts ar below, the male papilla.

tion. A key to the species of *Renicola* was prepared by Dollfus, based largely on the extent and location of the vitellaria. This feature is a conspicuous one and undoubtedly significant; it appears that the extension of the uterus into the caudal region of the body is also an important and distinguishing specific feature. Callot (1946) reported but did not name specimens of *Renicola* from *Sterna cantiaca,* "provenant des côtes de la Manche." He stated that the specimens did not correspond to any of the species described by Dollfus (1946).

A number of species in the genus *Renicola* have been described since 1946. Sudarikov (1947) described *Renicola pandioni* and *Renicola undecima,* both from *Pandion haliaetus* in the Gorkovsk Province of Russia. Bykhovskaya-Pavlovskaya (1950) described *Renicola mediovitellata* from the ducks, *Anas strepera, Nyroca ferina* and *Spatula clypeata* in Siberia, and *Renicola magnicaudata* from the barn swallow, *Hirundo rustica,* also in Siberia. From *Branta canadensis* McIntosh & Farr (1952) described *Renicola brantae,* a species in which the arrangement of the vitelline follicles is the same as in *R. mediovitellata,* one of whose hosts, *Spatula clypeata* is common in America. Timon-David (1952) described *Renicola bretensis* from the magpie, *Pica pica,* on the Mediterranean coast. Bykhovskaya-Pavlovskaya (1952) described *Renicola nana* from *Tringa totanus* in Siberia. Caballero y Caballero (1953) announced the identity of *R. lari* Timon-David, 1933, and *R. glandiloba* Witenberg, 1929. He described specimens from *Pelecanus occidentalis* as a new species, *Renicola thapari.* Wright (1954a) described *Renicola cruzi* from *Sterna maxima* and *Sterna hirundacea* in Brazil. He also listed but did not describe three additional species from Brazilian birds. One of them, from the white-bellied gannet, *Sula leucogaster,* is presumably identical with *Renicola mirandaribeiroi,* described from the same host by Teixeira de Freitas (1955). In a second paper, Wright (1954b) described specimens of *Renicola* from birds in British zoological gardens. Two new species were named: *Renicola pelecani* from *Pelecanus phillipensis* of Ceylon and *Pelecanus onocrotalus* of Calcutta, and *Renicola sloanei* from two penguins, *Pygoscelis antarctica* and *Eudyptes chrysolophus,* and from the common guillemot, *Uria aalge,* taken in Sussex, England. Three additional species were described briefly, but not named; also the species reported but not named by Hamerton (1934) was described from the original specimens. More recently, Wright (1957) reported two kidney-flukes from Sudanese birds. One of the worms was found in a cyst in the kidney of the Goliath Heron *(Ardea goliath)* and was described as a new species, *Renicola goliath.* The bird had been shot at least 1,000 miles from the sea coast, and for this and other reasons, Wright speculated on the possibility that some members of the genus *Renicola* may pass their life cycle in fresh water.

Wright (1956) reported on the life history and ecology of species in the genus *Renicola.* He discussed the morphological criteria on which species have been distinguished and the value of these criteria. He found that variation among specimens from a single host was so great that it could be explained only on the basis of multiple infections or the failure of previous workers to realize the extent of variation that may occur within a single species. A study of records of hosts and parasites convinced him that "host-specificity in the sense of a group relationship does not apply in this genus." Supplementing the accounts of earlier authors, he described the histo-pathological details of the infected kidney. He found cellular debris and excretory material from the birds in the ceca of the worms.

It is clear that existing descriptions have assumed a morphological rigidity that does not exist, but until experimental studies have measured the variation that may occur in a single, natural species, it is impossible to determine with assurance which of the presently described species are valid and which should be rejected. Because of the incomplete and unsatisfactory nature of many specific descriptions, it is impracticable to attempt a detailed comparison of the present specimens with previously described ones, but the present specimens do not correspond to existing descriptions in one or more of the following characters: extent and location of vitellaria, extent of uterus, location of acetabulum and gonads, total size and size of organs, especially the suckers, which are not influenced by the state or degree of reproductive activity.

Life History.—Stunkard (1932) described the excretory vesicle and flame-cell pattern of *Cercaria rhodometopa* Pérez, 1924, a parasite of *Turritella communis* at Roscoff, France. He predicated that "the excretory system is apparently well developed and probably has already attained the definitive form which will persist through all succeeding stages in the life-cycle of the species. The system is so peculiar and characteristic that it will afford a quick and certain criterion for the identification of later stages in the life-history, and may, indeed, lead to the correlation of this larva with an adult trematode having the same excretory pattern." Miriam Rothschild (1935) described four additional species of rhodometopous cercariae: *C. pythio-*

nike, C. herpsyllis, C. doricha and *C. nicarete* from *T. communis* at Plymouth, England, and two additional ones, *C. ampelis* and *C. ranzii,* from the same host-species at Naples, Italy. Behavior as well as morphology was recorded by Miss Rothschild. All infection attempts failed, and wide search for the metacercariae proved fruitless although Miss Rothchild correctly surmised that the second intermediate host is a fish. Rothschild & Sproston (1941) found encysted metacercariae in *Gadus luscus* and *Gadus merlangus* which agreed morphologically with the rhodometopous cercaria that Miss Rothschild had described as *C. doricha.* They reported earlier attempts to induce these larvae to penetrate *Gadus merlangus* and suggested that the infection of the fish results from ingestion of the cercariae. They stated, "The search for the final host should now be considerably narrowed as there are relatively few fish which both consistently prey upon *G. merlangus* and *G. luscus* and are common over the Rame Mud. . . . The fact that the intermediate host is found at a depth of 20 fathoms or more, and is yet commonly infected with *Rhodometopa* cercariae makes it exceedingly unlikely that the final host is a bird." Yamaguti (1939) described and figured *Renicola umigarasu* and *Renicola keimahuri.* Stunkard (1946) called attention to the virtual identity of structure between the excretory vesicle of these species and that of *Cercaria rhodometopa* Pérez, 1924. Referring to his earlier description and prediction, he declared that there is strong presumptive evidence that *C. rhodometopa* is the larva of a species of *Renicola.* Wright (1953) reported that the excretory vesicle of young specimens of *Renicola* which Campbell and Sloane had found in penguins hatched in the Edinburgh zoo, and which he subsequently described as *Renicola sloanei,* was similar to that of the Rhodometopa Group of cercariae described by Rothschild (1935). Shortly after Wright's publication, Timon-David (1953) reported metacercariae from the pyloric ceca, the intestinal wall and mesenteries of sardines in the Mediterranean; these parasites being similar morphologically to the rhodometopous cercariae, particularly in the excretory system. He stated, "Les affinités de cette métacercaire avec le groupe *rhodometopa* s'imposent, mais il est plus difficile de préciser à quelle forme elle correspond . . . C'est peut-être avec la forme type *C. rhodometopa* Pérez que la métacercaire de la Sardine présente les affinités plus accusées." Wright (1956) noted that the only common feature of the species which serve as final hosts of *Renicola* is their fish-eating habit.

The morphological agreement between the rhodometopous cercariae and the metacercariae from fishes, and of the excretory pattern of these larvae with that of members of the genus *Renicola,* provided clear evidence of genetic relationship. Only experimental confirmation of the life cycle and specific identification of the larvae and adults remained. In the examination of 1,400 specimens of *Turritella communis,* Wright (1956) found natural infections with three of the species described by Rothschild (1935), *viz., C. doricha, C. pythionike* and *C. nicarete;* also two additional species which he described as new, *C. doricha-pigmentata* and *C. cooki.* The first of these species, *C. doricha,* was associated by Rothschild & Sproston (1941) with the metacercariae found in *Gadus luscus* although they acknowledged that "Without experimental proof, however, it is difficult to assign metacercariae with certainty to any of the closely related species." Wright (1956) found that the eggs of *Renicola* spp. will not hatch in fresh, brakish or sea water but do hatch in the intestine of *T. communis.* He described the miracidia as pyriform, tapering anteriorly, with long cilia restricted to a collar or band situated about midway along the tapering anterior end. No eye-spots are present but two large cells of somewhat irregular outline are located just behind the anterior end. The eggs were ingested by snails, and specimens dissected 24 to 72 hours after exposure to the eggs had lesions on the outside of the intestinal wall, each of which consisted of a surrounding membrane and a number of cells, some of which stained intra-vitally with neutral red. It was suggested that these structures may have been early mother sporocysts. Other attempts were made to infect the molluscan host. Since it is impossible to raise *T. communis* from eggs past the veliger stage, the snails to be used for experiments were isolated for periods of two and one-half to four and one-half months. Wright (1956) named the birds from which the eggs of the parasite were obtained, but the species of *Renicola* were not identified. In the first experiment, 42 snails that had been isolated in the laboratory for four and one-half months were exposed overnight to eggs of *Renicola* sp. from *Colymbus arcticus.* The snails were dissected at intervals and one dissected at the end of three and one-half months contained very immature sporocysts in the gonad. In a second experiment, 69 snails, tested previously for a period of four months, were exposed to eggs of *Renicola* sp. from *Puffinus puffinus.* Sample snails were dissected over a period of three months but no infection was found. In a third experiment, 60 snails that had been tested for two and one-half months were exposed to eggs of the parasite from *P. puffi-*

nus. Dissection during three and one-half months failed to disclose infection, but four female specimens out of eight alive at the end of six months contained sporocysts, more advanced than those found in the first infection. No naturally emerged cercariae were obtained, but it is well known that many snails are not properly nourished under laboratory conditions and that the development of trematode parasites is delayed or suspended when the host is deprived of essential nourishment or kept under deleterious conditions. Apparently no attempt was made to infect fishes, although metacercariae of natural infections were compared with the bodies of cercariae and with juvenile worms from the intestine of naturally infected birds. Attempts to infect avian hosts were limited to the feeding of large numbers of metacercariae to a chick, a duckling and a gull, all of which were fruitless. However, the laboratory infection of the molluscan host is a distinct contribution to knowledge of the renicolid trematodes and together with other corroborative evidence demonstrates that the rhodometopous cercariae are indeed the larval stages of these trematodes and that fishes serve as intermediate hosts. Information is yet too uncertain to permit precise specific correlation of larval with adult stages.

Summary

Trematodes from cyst-like enlargements of the renal tubules of the pheasant-tailed jacana, *Hydrophasianus chirurgus* (Scopoli), are described provisionally as a new species, *Renicola philippinensis*. This is the first record of a *Renicola* from southeast Asia. Specific identity and life history in the genus *Renicola* are considered.

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EXPLANATION OF THE PLATE

Plate I

Fig. 1. Photograph of kidneys of *H. chirurgus,* showing cystic enlargements.

Fig. 2. Two specimens of *R. philippinensis.* The morphology of the longer one is shown in Text-fig. 1.

Fig. 3. Eggs of *R. philippinensis.*

Fig. 4. Section of renal tubule, showing the two worms in the dilated portion.

Fig. 5. Portion of the area depicted in Fig. 4, higher magnification, to show body-wall and spines of the parasite, and the intact epithelium of the renal tubule.

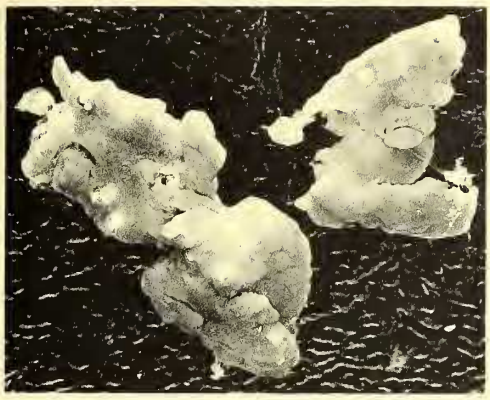

FIG. 1

FIG. 2

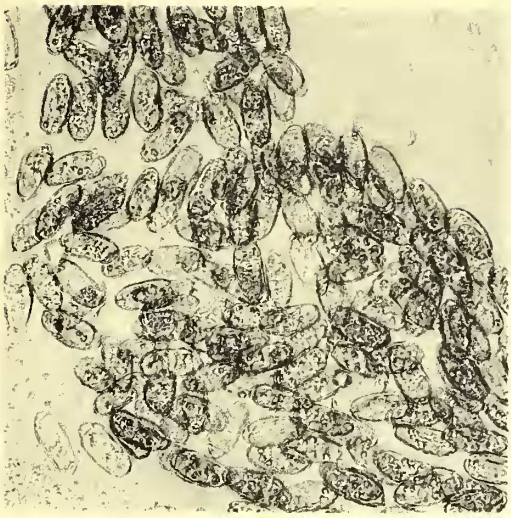

FIG. 3

FIG. 4

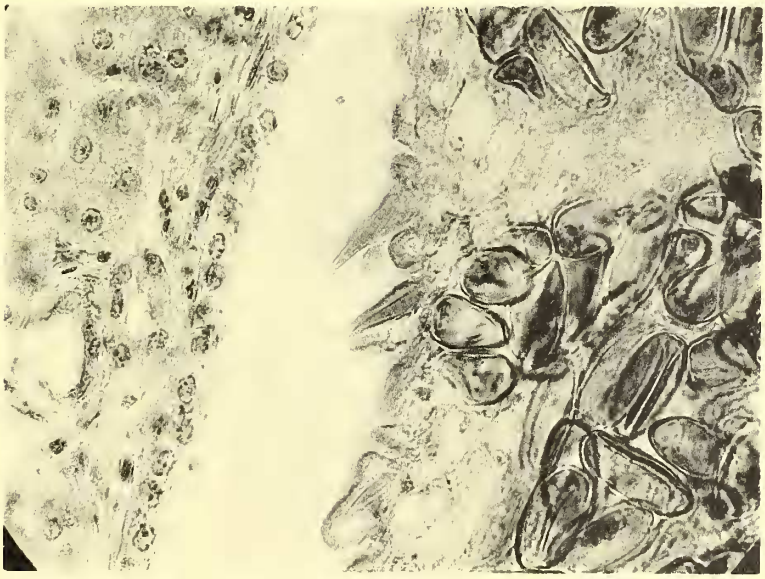

FIG. 5

THE MORPHOLOGY OF RENICOLA PHILIPPINENSIS N. SP., A DIGENETIC TREMATODE FROM THE PHEASANT-TAILED JACANA, HYDROPHASIANUS CHIRURGUS (SCOPOLI)